

REPORT DOCUMENTATION PAGEForm Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Service, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE (DD-MM-YYYY) 25-06-2001		2. REPORT DATE Type FINAL		3. DATES COVERED (From - To) June 1997 - May 2001	
4. TITLE AND SUBTITLE Biological Time Scales in Acoustic Backscatter from Littoral Bottom Boundary Layers				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER N00014-97-1-0643	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Dr. Peter A. Jumars				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) School of Oceanography University of Washington Box 357940 Seattle, WA 98195-7940				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Office of Naval Research 800 N. Quincy Street Arlington, VA 22217-5660				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSORING/MONITORING AGENCY REPORT NUMBER	
12. DISTRIBUTION AVAILABILITY STATEMENT There are no restrictions to distribution					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT We used time-series analysis with data from acoustic instruments, i.e., TAPS (Tracor Acoustic Profiling System) and BAMS and XBAMS (two versions of APL-UW's bottom-mounted sonar system) from several different localities. We supplemented acoustic data with trap samples and plankton tows timed to capture specimens to allow us to identify causes of acoustic events. In addition, we characterized bacterial and biopolymer coverage of sediments because of the potential effects of these viscoelastic materials on frictional loss between grains.					
15. SUBJECT TERMS benthic, backscatter. TAPS, BAMS, XBAMS, time-series analysis, acoustic backscatter, mysids, emergence behavior					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 3	19a. NAME OF RESPONSIBLE PERSON Dr. Peter A. Jumar
a. REPORT U	b. ABSTRACT U	c. THIS PAGE U			19b. TELEPHONE NUMBER (Include area code) 207-563-3146x242

20010629 027

FINAL REPORT

Grant #: N00014-97-1-0643 (AASERT)

PRINCIPAL INVESTIGATOR: Dr. Peter A. Jumars

INSTITUTION: University of Washington

PROJECT TITLE: Biological time scales in acoustic backscatter from littoral bottom boundary layers.

REPORTING PERIOD: 1 June 1997 - 31 May 2001

AWARD PERIOD: 1 June 1997 - 31 May 2001

OBJECTIVES: The broad objectives of this research were to characterize benthic and near-bottom contributions of biology to acoustic backscatter at high frequency (≥ 40 kHz), focusing on the time domain.

APPROACH: We used time-series analysis with data from acoustic instruments, i.e., TAPS (Tracor Acoustic Profiling System) and BAMS and XBAMS (two versions of APL-UW's bottom-mounted sonar system) from several different localities. We supplemented acoustic data with trap samples and plankton tows timed to capture specimens to allow us to identify causes of acoustic events. In addition, we characterized bacterial and biopolymer coverage of sediments because of the potential effects of these viscoelastic materials on frictional loss between grains.

ACCOMPLISHMENTS: The AASERT grant helped us complete analysis of a six-day TAPS record (Kringel et al., in manuscript) showing a shallow-water scattering layer. We identified it to be caused by vertically migrating mysids that spend daylight hours on or in the bottom or near-bottom turbid layers. We have subsequently found this phenomenon to be nearly universal, but with very interesting local variations. In particular, in coastal embayments with strong tides, there is strong tidal modulation of nightly emergence, with the highest per-hour rates of emergence corresponding with the highest shoreward velocities, suggesting a retention function. This emergence dominates backscatter from volume reverberation near the seabed, but it does not appear to dominate the rate of change of backscatter from the seabed. The latter usually reaches a peak at midday, and we have reason to believe, particularly from the SAX99 experiment, that pock marking of the bottom by feeding fish may be the dominant cause. Fish disperse away from the bottom at night, but collect in patches during the day. On the bacterial issue, we found that bacteria had very constant abundances per unit of volume of pore water (one billion per cubic centimeter; Schmidt et al. 1998), but that they were not concentrated at grain-grain contacts.

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

CONCLUSIONS: Our tentative conclusion is that emergence of backscattering fauna is a widespread coastal phenomenon, timed to prevent loss of individuals to visual predators. Visual predators, in turn, may dominate the rate of change in backscatter from the seabed and may set equilibrium seafloor roughness on a small scale (0.5-3 cm). At the bacterial scale, diffusional limitation provides the simplest explanation of bacterial abundance and spatial location (Schmidt and Jumars 2001).

SIGNIFICANCE: These biological phenomena set the backscatter environment for mine hunting. From the standpoint of mine hunting, the least biological noise near the seabed occurs after sunset and before sunrise, quite unlike the acoustic problem of hunting targets in the upper ocean. From the biological viewpoint, acoustics is providing data on near-seabed and seabed processes on unprecedented scales, i.e., short intervals and large spatial extents. Although they are not concentrated at grain-grain contacts, bacteria and their polymers are abundant enough potentially to significantly affect sound transmission by altering mechanical properties (i.e., friction between grains).

PUBLICATIONS: The AASERT grant has contributed in varying measure to a number of publications and manuscripts:

Schmidt, J.L., J.W. Deming, P.A. Jumars and R.G. Keil. 1998.

Constancy of bacterial abundance in marine sediments. *Limnol. Oceanogr.* 43: 976-982.

Schmidt, J.L. and P. A. Jumars. 2001. Clonal fitness of bacteria predicted by analog modeling. *BioScience*, in press.

Self, R.F.L., P. A'Hearn, P.A. Jumars D.R. Jackson, M.D. Richardson and K.B. Briggs. Effects of macrofauna on acoustic backscatter from the seabed: field manipulations in West Sound, Orcas Island, WA, USA. *J. Mar. Res.*, submitted

Kringel, K., P.A. Jumars and D.V. Holliday. A shallow scattering layer: high-resolution acoustic analysis of nocturnal vertical migration from the seabed. *Limnology and Oceanography*, in manuscript.

CONTRIBUTIONS TO HUMAN RESOURCE DEVELOPMENT: This AASERT grant supported the M.S. work of Keli Kringel and Ph.D. work of Jill Schmidt at the University of Washington, and it has begun the M.S. work of Heather Uhden and Leslie Harris at the University of Maine. Both of the latter two are continuing to work on emergence behavior under other funding.